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THE ENGINEERING PROFESSION FIFTY YEARS HENCE¹

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NEW YORK CITY

Prelude

ENGINEERING, in one sense the youngest and in another the oldest of all the learned professions, has attained its importance and high standing mainly during the last half-century. It is universally acknowledged to be the profession of progress; and all thinking people concede that without it the advancement of the world would come immediately to a standstill, and even the maintenance of modern civilization would be impracticable. Just imagine what civilization would be without the steam-engine, railroads, steamboats, bridges, the telegraph, the telephone, water-works, sewerage, the typewriter, electrical machinery, the gas-engine, the automobile, mining, metallurgy, applied chemistry, water-power, steel buildings, reinforced-concrete constructions, agricultural machinery and irrigation! All these activities and many others too numerous to mention come within the province of the engineer, and their development has been his task. The importance of the engineer in the community was emphasized in polished language as follows in an editorial of the *Canadian Engineer* for October 18, 1917:

¹ Before starting to prepare this article, the author wrote to a number of his good friends in the various branches of engineering, and propounded to them the following questions:

"A. What deficiencies, shortcomings, or defects do you note in our profession in general, and how would you suggest correcting them?"

"B. In regard to your own specialty, what improvements would you desire, and how do you think they may be effected?"

"C. In your special line of work, have there been any fundamental novelties or drastic innovations suggested which are either practically feasible or even possible of future adoption? If so, please give a brief description of them; or, if they have been already described in print, tell me where I can find the information."

A few of the responses received to these questions furnished data of considerable value to the speaker in preparing this manuscript; and he takes this opportunity heartily to thank, individually and collectively, the gentlemen who so generously responded to his appeal for aid. It is deemed inadvisable to enumerate their names, especially in view of the fact that their contributions have been utilized mainly as suggestions for development rather than for direct quotation. This arrangement was understood at the outset by all concerned.

Every industry depends directly upon the engineer. There are few points of life where his work has not effected big alterations. Tolerant

he must be to human weakness; efficient he must be, for in few other fields of effort is the elimination of the unfit more rigorously practised. His training is applied science, and his practise demands large common-sense.

The engineer is one of the pivots of modern civilization; therefore he should be more in evidence as a public man. He is well fitted to carry forward the lessons of practical experience in the realm of national affairs.

In war as well as in peace the engineer stands preeminent, as is evidenced in the present struggle, by such prominent military men as Joffre, Kitchener, Cadorna and von Ludendorf.

The world could manage to dispense with lawyers and clergymen, and, possibly, even with physicians, but it would be impracticable to get along without engineers. Very few people, however, have looked at the matter in this light; and the engineer, in consequence, has not yet received from the public the consideration which is his due, nor the pecuniary compensation which his services merit.

The fundamental reason for this undesirable state of affairs is, undoubtedly, the newness of engineering as a learned profession, but it must be confessed that much of the blame therefor lies with the engineers themselves. They have been so intent on their own individual activities that they have not fully organized for their protection as a class; and although the engineering societies, both large and small, have done great work and have accomplished much towards the betterment of conditions, their effectiveness is far from being ideal. The larger societies are too cumbersome to accomplish desired reforms in any reasonable length of time, and the smaller societies generally have not in their ranks enough men of prominence.

Recognizing this, some years ago a few engineers in independent practise founded the American Institute of Consulting Engineers. It is proving, in certain lines, to be a most excellent organization; but its field of usefulness is too limited. Its objects are in a certain sense selfish; and its constitution excludes all engineers who are engaged in contracting and most of those who are in the employ of manufacturing or contracting companies.

Some eight years ago a few engineers came to the conclusion that the profession needs at its head a comparatively small and select body of engineers chosen from the leaders in every branch of activity and from all parts of the country, in order to undertake those duties which the existing societies neglect. They, consequently, endeavored to organize an "American Academy of Engineers" on the broadest and most altruistic

lines; but they encountered many obstacles which delayed for a long time the accomplishment of their purpose. The principal stumbling block was the difficulty in organizing without subjecting the charter members to the accusation of being self-appointed. It was claimed, and very properly, that the making of such an accusation would militate seriously at first against the effectiveness of the academy, and might even be the means of ultimately preventing its successful establishment.

Great undertakings are apt to move slowly; and such was the case in this endeavor, for it was not until the end of 1916 that a truly impersonal means was evolved for the selection of the nucleus of the Academy. The *modus operandi* finally adopted was as follows:

The Honorable William C. Redfield, secretary of commerce, who for several years had taken a deep interest in the undertaking, and who had been requested in writing by many prominent engineers from all parts of the United States to take the initial step towards the formation of the academy, appointed Major-General George W. Goethals as the first member, and instructed him to select nine others from among the most prominent engineers in all branches of the profession, limiting his choice by the inclusion of at least one past-president from each of five national engineering societies which he named. General Goethals in complying with his instructions went a step farther by selecting one past-president from each of eight national engineering societies, thus covering practically all lines of the profession, and two at large, dropping out himself on the plea that he objected to accepting a government appointment to such an organization. The ten engineers thus chosen met at once in order to select the other forty engineers so as to form the nucleus of the academy and then apply to Congress for a national charter, all in accordance with the program of Secretary Redfield, as indicated in his letter of instructions to General Goethals.

At the first meeting, which was held in New York City, it was unanimously decided that General Goethals should be the first one chosen, and that he should be requested to aid in the selection of the remaining thirty-nine, to which arrangement he subsequently agreed. The method employed was to let each of the eleven members nominate as many suitable candidates as he might desire, and from these, by a process of elimination, to choose the number required. Over one hundred names were proposed, and approximate percentage-limitations for the various groups of engineers were agreed upon. A number of meetings, extending over several weeks, were found necessary.

Each candidate's fitness was thoroughly discussed, and his proposer was required to state in writing the said candidate's professional record and the reasons why he was believed to be specially eligible. A consideration of geographical location was deemed requisite; and for that and other good reasons it was found necessary to exclude temporarily a number of engineers who are in every way eligible. Not one of the fifty gentlemen thus chosen as charter members failed to accept his election.

By direction of Secretary Redfield, the solicitors of the Department of Commerce prepared the draft of a bill for the incorporation of the academy; and this bill was introduced in both the Senate and the House of Representatives. It was passed by the Senate during the late special session of the Congress; but the judiciary committee of the House postponed its consideration until the next regular session. Arrangements are being made for the said judiciary committee to take up the consideration of the bill in the immediate future.

Some opposition has been raised by a few engineers to the granting of a national charter to the academy, the cause apparently being an absolutely unfounded fear that the new organization will usurp some of the functions of the existing national technical societies, but mainly because the true intent of the academy is not generally known or understood.

The fundamental reason why it will eventually succeed in accomplishing many important desiderata for the profession where the large national technical societies have failed is that there are in each group or line of engineers a few individuals who have a deep love for the profession, and who are ever ready to subordinate to its welfare their own personal interests—men who generously spend time, effort and money in giving to others by their writings the benefit of their knowledge, accumulated through many years of hard work—men, too, who are prominent in research, in originality, in organization, in altruism and in energy. If all, or a large proportion, of such men from every line of technics were combined into an academy, having a membership limited to two hundred, is it not evident that the amount of good which they could accomplish would be enormous and that the results of their efforts would be far-reaching and invaluable? It is mainly of such men that the American Academy of Engineers is and will be composed. The fifty names of the charter members are a proof of the correctness of this assertion; but additional evidence is given by the following quotations from the temporarily adopted Constitution and By-Laws:

Professional Objects.—These shall be: To dignify and to exalt the profession of engineer in the broad sense, and to place it upon the highest plane amongst the liberal professions; to bring the different branches of the engineering profession into closer touch and harmony with each other; to bring American and foreign engineers into closer relations with each other; and to secure for the engineering profession as a whole the recognition that is commensurate with the importance of its services to the world.

National and Civic Objects.—These shall be: To render to the government of the United States of America or to any commonwealth of the nation, when so requested, service in the field of engineering, industrial technology, and applied science; to cooperate, in rendering such service, or for any purpose involving the welfare and interests of the country, and to subserve the same, with American national academies, institutes, societies, or bodies interested in pure and applied science, technology, and engineering.

Ways and Means.—The academy will strive to accomplish these objects by all proper, honorable, and legitimate ways and means; by fostering, stimulating, and encouraging the growth and development of the highest professional spirit, ideals, and ethics uniformly in all branches of engineering; by promoting a better understanding and sympathy between these different branches; by advocating more homogeneous and consistent rules and precepts for their guidance in their relations with each other and with the rest of the world; by working for general cooperation and solidarity; by fostering an *esprit de corps* in the profession as a whole; by doing all in its power to elevate the standards and promote the interests of the profession; and by urging its claims, or those of its more distinguished and eminent votaries to due and proper consideration for public or private honor or recognition. . . .

Members.—Members shall consist of properly qualified engineers having eminence or distinction in one or more branches of engineering, by reason of their professional attainments, learning, or experience, and of their contributions to the progress and advance of their branch or branches of engineering or of the engineering profession as a whole.

The qualifications of a candidate for member shall include the following requirements:

- (a) He must be a citizen of the United States of America.
- (b) He must be at least forty years of age.
- (c) He must be a member, in good standing, of the highest grade, in at least one national engineering or technical society in the United States of America.
- (d) He must have practised or else taught engineering, or some cognate branch of technology (such as chemistry), continuously for a period of not less than fifteen years, and he must be still engaged actively in practising or teaching or both; or else, in lieu thereof, he must have been identified with work of importance, either by reason of its magnitude or else because of its novel or special character; and it must be shown that he has made a satisfactory record and has obtained a good standing in his branch of the profession through his technical work.

(In the case of a teacher of engineering or of technology, the publication of original books relative to his branch or branches of the profession shall be taken as the equivalent of engineering work.)

- (e) He must have a personal as well as a professional record, reputation, and standing, entitling him to the highest consideration as a pro-

professional gentleman who is devoted to the progress and advance of the engineering profession and who is interested in promoting the welfare and sustaining the dignity of that profession.

Other qualifications, constituting criteria of eligibility to membership, are prescribed in the By-Laws. . . .

Eligibility.—The additional qualifications, referred to in Article II of the Constitution as constituting criteria of eligibility of a candidate for member of the American Academy of Engineers, shall be such as indicate the general education, the technical training, and the professional experience and record of the candidate. They shall include the following requirements:

(f) He must have a degree from a university or technical school of recognized standing.

(g) He must have a reading knowledge of at least one European language, or else of Esperanto, besides the English language.

(h) He must have been in responsible charge of engineering or technical work or design for a period of not less than five years. If teaching, he must have been in charge of a department in a school of recognized standing for a period of not less than ten years.

(In the case of candidates who have taught and practised at different portions of their careers, two years of teaching shall be considered the equivalent of one year of engineering practise.)

(i) He must be the author of at least one important original publication on some subject or topic related to at least one branch of engineering.

In general, the intellectual status of the candidate, and the personal traits or qualities making him a credit to the profession of engineering, and, especially, his zeal and devotion to that profession, shall be the paramount considerations in determining his fitness. His financial status shall be of no consideration whatever.

Waivers.—Any of the foregoing requirements may be waived in any particular case in behalf of a candidate otherwise very desirable; but the said waiver shall be only by the unanimous vote of the Board of Directors. . . .

Scope and Program.—The academy shall avoid encroaching upon the scope and program of any of the engineering and technical societies representing special branches of the engineering profession, and it shall limit and confine its activity to questions of such nature and character as are likely to interest and to affect the profession as a whole. These questions may include ethics, relations with other professions, matters of general professional policy or expediency, questions of political or commercial economy involving engineering, national and international engineering topics, etc.; and the program shall specifically exclude engineering and professional papers of the types usually presented before the various engineering and technical societies.

Communications from non-members, when introduced by a sponsor member of any class, may be presented and published with the approval of the publication committee.

Annual Publication.—This shall contain the proceedings of the meetings, and the reports, including discussions, of papers and communications presented before the academy and approved by the publication committee for publication.

A copy of the annual publication shall be sent gratis to every member, emeritus member, and honorary member of the academy; to every important national engineering society in the world; to the governor of

each state and territory, to the library of every university and technical school of recognized standing in the United States, and to the libraries of certain foreign institutions of learning. The list of institutions and individuals to whom copies are to be sent gratis shall be subject to the approval of the publication committee. Copies shall also be available at a reasonable price to any person desiring the same, if ordered before publication, or otherwise if there be copies available.

An apology is due for the length of these quotations from the constitution and by-laws; but the purpose the writer has in mind in making them could not well be accomplished by shortening them in any way. These extracts show not only that the American Academy of Engineers is to be a technical and scientific society of the highest possible order, but also that its aim is to supplement—not to supplant—the other national technical societies.

Through its honorary members, who are citizens of foreign countries, American engineers will be brought in contact with their professional brethren abroad; and a large amount of business for our country will certainly result from this connection—business which otherwise would naturally go to other countries than ours.

It seems to the writer that no truly broad-gauge man in any walk of life can oppose the incorporation of the American Academy of Engineers as a national organization; for, unless it were given governmental recognition, it would not be regarded by people in general as the national association of engineers chosen from every line of technics, nor as the select body of practitioners which it is intended to be; and, therefore, its capacity for doing good would be most effectually curtailed. Again, it would not be properly recognized, at least for many years to come, by foreign governments and foreign technical and scientific societies, nor could it act, in the manner intended, as a court of last appeal for American engineers in all lines of the profession. Moreover, the national and the state governments would not feel that they have the right to call upon it for advice and assistance to be given gratis, unless it were a national body; nor could it properly take the initiative in many important movements affecting the welfare of the commonwealth. For these reasons, and for other important ones too numerous to state, it is to be hoped that nothing will prevent the granting of a national charter to the American Academy of Engineers at the present session of Congress.

The principal existing “deficiencies, shortcomings, or defects” in the engineering profession in general, as indicated by a consensus of the answers to questions *A* and *B* of the circular

letter which, as previously indicated, the writer sent to some of his technical friends before starting to prepare this lecture, are, in the indicated order of importance, as follows:

- A. Lack of appreciation of the profession by the public.
- B. Deficiency in general education on the part of most engineers.
- C. Lack of culture.
- D. Failure of the technical schools to provide proper instruction in the English language.
- E. Failure of the technical schools to give a broad, general education.
- F. Uncertainty as to the definition of the term "engineer" and exactly the class of men which it should include.
- G. Too small compensation for engineers.
- H. The fact that engineering is too largely a profession of regularly employed men; or, as it has been rather pithily but inelegantly stated, that "too many engineers wear the brass collar."
- I. Need for a license system—federal, but not state.
- J. Lack of publicity concerning engineering achievements and general technical news and interests.
- K. A tendency among some engineers for one man to appropriate another's inventions or ideas.
- L. Undue criticism of one engineer's work by a brother engineer.
- M. Failure on the part of engineers to recognize what the profession really is.
- N. Need for a clearer appreciation by engineers of the rôle they are called upon to take.
- O. Lack of loyalty to the profession and to the members thereof.
- P. Giving of advice and doing of preliminary work gratis.
- Q. Deficiency in accurate thinking.
- R. Lack of accuracy in doing work.
- S. Carelessness and slovenliness.
- T. Lack of address, and inability to speak well.
- U. Inability to write well.
- V. Lack of initiative in public affairs.
- W. Improper methods of instruction in technical schools.
- X. Ignoring of individuality in students by teachers of technics.
- Y. Lack of direct connection between research and engineering practise.
- Z. A tendency to usurp the title of consulting engineer by those who are not equipped to bear it.
 - a. Inability of many engineers to handle men.
 - b. Need in this country for a better patent system.
 - c. Opposition in America to the trying out of new devices and processes, and waiting instead for Europeans to make the trial.
 - d. Favoritism instead of merit as the reason for promotion of employees in large companies.
 - e. Need for a fixed minimum-fee basis for engineers' compensation.
 - f. Need for greater standardization of engineering practise.
 - g. Need for "abbreviated engineering data."
 - h. The study of one branch of engineering at school and subsequent practise in another branch.

The preceding is a rather appalling list of the alleged "deficiencies, shortcomings, or defects" that exist in the engineer-

ing profession; but it must be remembered that it represents the combined complaints of more than twenty engineers, representing all the leading branches thereof, each individual, of course, contributing his pet grouch; nevertheless a careful study of the list will convince one that each allegation is fairly well founded, and that the existence of many of them is beyond dispute. Remember, too, that these deficiencies apply to the profession as a whole, including the rank and file, and by no means to all of its members.

A study of the list will show that most of the deficiencies are of such a character that they are not corrigible by any of the existing technical societies; but they certainly are by an organization of the peculiar character and scope of the American Academy of Engineers.

Dr. C. O. Mailloux in his presidential address to the American Institute of Electrical Engineers spoke as follows:

We must show to the rest of the world that engineers are, by education, training, and experience, as well qualified as any professional class, to discuss and deal with public questions and problems, and that in the case of technical questions we are better qualified than are the other classes.

We not only fail in our duty to our professional class, but we also fall short of doing our full duty to the community by remaining silent in the social and civil background, and by hiding the important light which we are most able to shed on many public matters by virtue of our scientific and technical training.

It is a certainty that much remains to be done to put our profession upon the high plane where its importance to humanity entitles it to stand, and that reforms can be instituted only by concerted effort. The large national technical societies have gotten into ruts, and it is hard to jog them out—besides, the unwieldiness inherent in their great bulk militates strongly against a combination of all their efforts. It is far better to choose a limited number of the most live, energetic, earnest and altruistic members of each group and form them into a new organization which will act in concert and harmony with all the other national technical societies, as has been done in the case of the American Academy of Engineers. The new society could take the initiative and then apportion most of the work among the other organizations, reserving for itself the unusual or general tasks which no one of the other societies is specially fitted to handle. If the academy, after having been granted by Congress a national charter, were properly officered and systematically operated, there would be, ere many years, a wonderful improvement in the general status of the engineering profes-

sion; and most of the evils complained of would be fairly well corrected. Perfection, of course, can never be attained, but it is practicable to approach it by an asymptotic curve.

The present is the psychological time for bringing the engineering profession into its own; because never before in history has mankind been so dependent upon the engineer. The existing war is essentially a war of engineers; for it is they who are manufacturing the guns, ammunition, vessels, motors, and the other paraphernalia requisite for carrying on the struggle, and who are attending to the transportation of men, munitions, food, and all other supplies by both land and sea, besides doing their fair share of the fighting. The public is now beginning to recognize the truth of the sayings that, "when something of importance has to be done, it is necessary to call in the engineer," and that "engineers are preeminently the producers of results."

Concerning the relative importance of the engineer's work in the world to-day, it may be stated, without any reservation, that it is he who is responsible for our present civilization in the material sense and even, possibly, also in the mental sense. It is truly an engineer's age. Countries are built up and torn down by the engineer. He is a creator; he brings together elemental forces and gives them direction. He takes the natural things from the earth and makes of them the complex things of life. If his work were to cease, the world would retrograde to uncivilization as we understand the word to-day.

The speaker has stated that "the present is the psychological time for bringing the engineering profession into its own," but he wishes to add to this another claim, viz., that it is also the psychological time for our country to secure the trade of Latin-America as well as to prepare for obtaining the lion's share of world-reconstruction after the war. Both of these tasks are work for the engineer, because it is he who first will have to go to those countries in order to spy out the land, determine what works of construction are necessary, and do missionary work for American manufacturers, capitalists, and contractors; and it is a *sine qua non* that the reconstruction mentioned is essentially his *métier*. Such being the case, now is the logical time to improve the engineering profession in America so as to enable its members to render the most effective service possible in these activities of national importance.

Perhaps the most outstanding factor at the present time, bearing upon the future of engineering, is the new standard of values brought about by the war. This is, undoubtedly, the

most widespread and revolutionary change in the history of mankind. Not only have money values varied greatly in a short period of time, but the war, on account of its widespread nature and because of the vital principles affecting the future progress of mankind, for which the Allies are fighting, has brought us face to face with one of the most important stages in the cycle of civilization.

Engineering works are the surest index to the state or degree of civilization to which a nation has arrived; and, owing to the rapid progress and readjustments which will be the outcome of the war, these same works will undergo a more rapid change and growth in a given time than history has yet shown. What may have seemed a colossal engineering work a few years since will become commonplace henceforth. An illustration of this is the growth in the size of steamships. How many times we have heard of huge vessels having been constructed and regarded as the final word in marine architecture! Drydocks have been built to take care of the largest vessel that would ever be constructed, yet in a few years these same docks are found to be totally inadequate to handle anything but that which has come to be considered a vessel of ordinary size. The same remark applies to bridge loadings. Many bridges have been built to take care of all possible future loads, and yet the weights of locomotives and loaded cars have increased so fast that the structures are out of date long before they show any sign of deterioration from the elements. This analogy could be continued indefinitely to apply to actual cases concerning transportation systems, office buildings, canals, water-works, etc.

The increase in requirements or demand seems to be in an ever-augmenting ratio, the curve varying with the periods of business prosperity and depression. In short, engineering works will always meet the demand; and the demand is increasing steadily. It is quite reasonable to imagine the City of New York as having grown to a city of twenty million inhabitants; and when such a change exists, there will be engineering works such as bridges, tunnels, water-works, transportation systems, etc., in which almost inconceivable sums of money have been invested. If there is a compelling need for a structure of unprecedented size, then that structure will be built—the cost is merely a relative matter. Given enough money (and the money will be found, if the need is sufficiently imperative), there is almost no engineering feat that can not be accomplished.

(To be continued)